QH359
.E76

5.06 (73) Ha

EVOLUTION

1-4 1927-38

AMNH LIBRARY
100115223

SHOUT
SHARE
IT

FOR THE PEOPLE
FOR EDVCATION
FOR SCIENCE

LIBRARY
OF
THE AMERICAN MUSEUM
OF
NATURAL HISTORY

Gaylord
MULTIBINDER
Syracuse, N Y
Stockton, Calif.

5.06(73)Ha

Vol. III. No. 1 JUNE 1930 20 Cents

EVOLUTION

CHARLES DARWIN

EVOLUTION

A Journal of Nature

To Combat Bigotry and Superstition and Develop The Open Mind by Popularizing Natural Science

L. E. KATTERFELD, *Managing Editor;* ALLAN STRONG BROMS, *Science Editor;*
MAYNARD SHIPLEY, EDWIN TENNEY BREWSTER, HORACE ELMER WOOD II
Contributing Editors

IN RESUMING PUBLICATION of EVOLUTION we wish to express our appreciation to all those loyal readers whose assistance has made this possible. We shall now come out regularly, and feel sure that an ever growing circle of readers will deem EVOLUTION worthy of their active co-operation. EVERY reader is invited to take part in this effort to *dispel the darkness* by *spreading the light.*

PERMIT US TO INTRODUCE three "contributing editors," who have already assisted in the production of EVOLUTION in the past. *Edwin Tenney Brewster* is author of "Creation: A History of Non-evolutionary Theories" and of "This Puzzling Planet;" *Maynard Shipley* is President of the Science League of America; *Horace Elmer Wood II* is Professor of Geology at New York University.

COMMEMORATING THE FACT that the first public recognition accorded Charles Darwin from abroad was his election to the Philadelphia Academy of Natural Sciences upon recommendation of Joseph Leidy and Isaac Lea, Dr. Joseph Leidy II, representing the American Association for the Advancement of Science, presented a bust of Darwin at the recent dedication of Darwin's old home, Down House, as a public monument. EVOLUTION joins in honoring *The Great Emancipator of the Human Intellect* with the reproduction on the front cover.

WHY THE EVIDENT DESIRE of a number of American scientists to erase the "taint" of our ape-ancestry? What is there about it to fill us with either pride or shame? Isn't it merely a question of FACT? It may easily be true that Man has been Man for a much longer period than we had thought. If so, what of it? Suppose even that Man has never passed through an arboreal stage. Again, what of that? EVOLUTION holds that our opinions on these points should be based solely upon what are found to be the facts, and influenced not at all by any yielding to popular prejudice. Certainly not a single reputable scientist living today denies the Man-Ape relationship outright. The dispute is merely as to the *degree* of this relationship, and that can only be settled definitely upon the basis of additional evidence. Any feeling of "disgrace" in this connection is unscientific sentimentalism, and ill serves the cause of Truth. "Soft-pedalling" may be good for popular publicity, but a scientist who presents his case so that even fundamentalist dogmatists can quote him with approval as supporting them deserves no sympathy in his predicament.

L. E. K.

A Real Education

By THOMAS HENRY HUXLEY

SUPPOSE it were perfectly certain that the life and fortune of every one of us would, one day or another, depend upon his winning or losing a game of chess. Don't you think that we should all consider it a primary duty to learn at least the names and the moves of the pieces, to have a notion of a gambit, and a keen eye for all the means of giving and getting out of check? Do you not think that we should look with disapprobation amounting to scorn, upon the father who allowed his son, or the state which allowed its members, to grow up without knowing a pawn from a knight?

Yet it is a very plain and elementary truth that the life, the fortune, and the happiness of every one of us, and, more or less, of those who are connected with us, do depend upon our knowing something of the rules of a game infinitely more difficult and complicated than chess. It is a game which has been played for untold ages, every man and woman of us being one of the two players in a game of his or her own. The chess-board is the world, the pieces the phenomena of the universe, the rules of the game are what we call the laws of nature. The player on the other side is hidden from us. We know that his play is always fair, just and patient. But also we know, to our cost, that he never overlooks a mistake, or makes the smallest allowance for ignorance. To the man who plays well, the highest stakes are paid, with that sort of overflowing generosity with which the strong shows delight in strength. And one who plays ill is checkmated—without haste, but without remorse.

Well, what I mean by Education is learning the rules of this mighty game. In other words, education is the instruction of the intellect in the laws of nature, under which name I include not merely things and their forces, but men and their ways; and the fashioning of the affections and of the will into an earnest and loving desire to move in harmony with those laws. For me, education means neither more nor less than this. Anything which professes to call itself education must be tried by this standard, and if it fails to stand the test, I will not call it education, whatever may be the force of authority or of numbers upon the other side.

When you know a thing, to hold that you know it; and when you do not know a thing to allow that you do not know it—that is knowledge.

Confucius.

EVOLUTION, June 1930. Vol III No 1. (Serial number 16) Published Monthly by EVOLUTION PUBL. CORP. 112 E. 19 St. New York. Application for Second Class Entry pending, at Post Office, New York, N. Y. Subscription $2.00 a year; in lists of 5 or more, $1.00; Foreign 10c extra; Single copy 20c; bundles of 10 or more 10c.

How Evolution Works

By H. J. MULLER

I. IS EVOLUTION A "FACT?"

IS evolution "a fact?" Am I a fact? What is a fact? The philosopher says that he can not say I am a fact, but that he knows *he* is a fact, and that that is all he knows for sure, but I am not sure he knows that much. However, I will not dispute it with him. He and I and evolution may all be a hoax, but I think we have enough evidence to convince us that we will all have to stand or fall as hoaxes together. And that is enough to satisfy me, at the present stage of the game. If I am a hoax, you may be sure then there is no evolution, and if evolution is a hoax you may be sure there is no me, but if either evolution or I exist, then you need not doubt that the other exists too, and by the same token: for it is by the same process of piecing together, interpolating, a kind of continuity in the intervals between the separated but consistent momentary glimpses of us which you get sense evidence of from time to time, that you can reconstruct a convincing concept of each of us, evolution and me. Certainly, if any one could prove that evolution had not occurred, in spite of the overwhelming evidence we have of it, I should have my conception of the consistency of the universe so destroyed that I should see little reason left to credit the truth of my own existence. So remember, if you will, evolution is not a fact—no, not at all—no more a fact than that I exist or that you are reading the words on this page.

H. J. MULLER

It ill befits us, however, to remain wrangling over such abstractions when we stand confronted with the view of a great hitherto unknown world of which we form a part. Admitting, for purposes of living, the reality of this world of ours, we must forthwith bestir ourselves to find out its possibilities and the rules which govern its activities. Even though we may be but as little motes drifting helplessly in its great currents, still we can not keep our self-respect as men without striving to understand its operations, and, if possible, to make at least some little impression upon them. What, then, are the methods of operation of these great evolutionary processes in which all life has been caught?

This article, given originally as a public lecture on "the Method of Evolution" at the University of Texas May 6, 1929, has been brought up to date by the author.

II. THE QUARREL OVER THE CAUSATIVE AGENT

It is here that the real doubt and divergence of opinion among the so-called "experts" has been supposed to exist. "Darwinism is dead," it is sometimes parroted, and though Kammerer died tragically by his own hand, the hypothesis of the inheritance of acquired characters which he among others advocated is claimed to have plausibility. Many, if not most, medical men still believe in it, but some philosophers prefer evolution through a kind of inner drive—"orthogenesis:" still others who make themselves heard believe that instead, or in addition, there is a direct influence of the kind of environment upon the kind of variations that occur, with the result that fitter and fitter, or occasionally, less and less fit, organisms are brought into being. To "explain" the fortunate adaptive responsiveness on the part of the organism, the guesses range from an internal, rather short-sighted, cell-intelligence, the "enteleche," to an external, far-visioned perfecting principle.

Amongst the various voices—so our students have to learn from some contemporary texts—there are also to be heard the voices of "neo-Darwinians," who arrive at a finite end by an almost infinite number of steps, or slides, back and forth, of almost zero individual magnitude, the backslides, however, being each time discontinued. And opposed to these, it is often stated, are the voices of different kinds of "mutationists." Some of the latter would have one adapted species change directly into a differently adapted species by just doing so; others would have each more advanced type emerge out of the more primitive type by losing an inhibition. Then, too, there are the voices of those claimants who say that new products arise only by the crossing of preexisting types, followed by the formation of a combination type representing certain elements from each of the old. It is not explained here whether the second species arose by crossing between the first and third or whether the third species arose by crossing between the first and second, or both. Altogether, you see, this is not a process of a species raising itself by its bootstraps—not so crude. Here *A* lifts *B's* bootstraps, and *B* lifts *A's*, onward and upward forever!

After such a maze of opinions, of which these form only a part, the slate is left pretty blank (or rather, evenly scrawled over) for the teacher, the student or the outsider to write in, large, his own personal beliefs. Among these, there is one common. It starts out by stating that every effect has its cause, and a definite effect has a definite cause, and goes on to say that therefore it is only reasonable to suppose that a definite kind of varia-

tion, or difference arising between an offspring and its parent, must have been due to some definite condition or stimulus, within or surrounding that parent, whether we can at present trace it or not. A repetition of this condition then would bring forth a similar variation again. In some quarters it is added further that such causation must therefore tend in itself to explain the course of evolution. This in turn would seem to circumvent the necessity of invoking "natural selection" to do more than help out in a secondary and occasional fashion. For it is often said it feels "*philosophically unsatisfying*" to believe that all the order and organization of living things could have come about through such a chance process as natural selection admittedly is.

It is evident that a real decision of the questions at issue can be reached only on the basis of real data regarding the nature of those differences which distinguish one generation of individuals from its predecessors, and which they in turn tend to transmit as a heritage to their descendants. That is, we must not remain content to view evolution from afar, but must view close up, as through a microscope, the transitions now occurring out of which the evolutionary story is pieced together. The science which essays this study is "genetics."

III. GENETIC PRINCIPLES REVIEWED FOR THE NON-BIOLOGIST

During the present century genetics, building upon the earlier discoveries of Mendel, has practically solved the problem of the method of inheritance of the differences referred to, once they have arisen. All modern genetic work converges to show that the heritable differences between parent and offspring, between brother and sister, in fact, between any organisms which can be crossed, have their basis in differences in minute self-reproducing bodies called genes, located in the nucleus of every cell. The genes themselves are too small to be separately visible, but hundreds or thousands of them are linked together into strings, and these strings of genes, together probably with some accessory material, are large enough to be seen through the microscope by the cytologist; they constitute the sausage-shaped bodies called chromosomes. We know that, ordinarily, each individual gene in a string is different from every other gene in the same string, and has its own distinctive role to play in the incomparably complicated economy of the cell. Moreover, the genes in different chromosomes are different from one another, except in the case of homologous or twin chromosomes, *i.e.*, the corresponding chromosomes which each cell of an individual received from the father and from the mother of the individual, respectively. To match each chromosome that was derived from your father, every cell of you has in it also a similar chromosome(though not necessarily quite identical) derived from your mother, so that it contains in all two complete sets of genes . The proper functioning of the cell during its life depends upon the proper cooperative functioning of its thousands of different genes.

Each given gene in the cell must of course have its own specific chemical composition, differing from gene to gene, though there is no doubt a chemical relationship between all genes. As yet, however, we have no knowledge as to what the chemical composition of any individual gene, or of genes as a group, is. Whatever it is, we can not escape the fact that the different genes, through differing chemical reactions with other substances in the cell, produce by-products which have a very profound influence upon the properties of the protoplasm. And through the combined influences of all the chemical products of the thousands of different genes in a cell, meeting one another in the common protoplasm and then interacting in devious ways to form further products again, the exact form and physical and chemical characteristics of all parts of the cell that contains those genes will be determined, for any given set of outer conditions. Changing conditions external to the cell will of course change the properties of the protoplasm too, but what form and behavior it can and will show for a given set of outer conditions depends primarily upon what genes it has. And since the body of a man or other animal, or a plant, is made up of its cells, and the form and other properties of that body depend upon the properties of these constituent cells—their form, the way they fit together and work—it is evident that, less directly but no less surely than in the case of the individual cells, the characteristics of the whole body depend upon the nature of the genes in the individual cells.

These individual cells of the body have, during the development of the embryo, been derived from the original fertilized egg cell, through a succession of cell divisions in the course of each of which every chromosome and every gene present in the dividing cell also divided in half, one half of every chromosome and gene then entering one of the two daughter cells and the other half entering the other daughter cell. Between divisions the chromosomes and genes usually had a chance to grow back to their original size. Thus it results that every cell of the body has the same kinds and numbers of chromosomes and genes as the fertilized egg had, and as every other cell in the body has. The original two sets of genes of the fertilized egg—one set received from the sperm of the father, the other similar set derived from what the egg of the mother contained before fertilization —are still both present in every cell of you. But these two sets of genes of the fertilized egg were all, and more, than were needed to result in a complete man. We see, then, that every single cell of you, in the skin, the brain or anywhere else, contains the makings of a complete man or woman, and that you are in this sense wrapped up within yourself many trillion fold. Not each cell may grow up into an entire man, of course, but must remain content to do its specialized share, even though it has a full

(*Continued on page* 14)

Present Problems of Evolution

By EDWIN G. CONKLIN

IN spite of much antagonism and some legal prohibitions in some backward states, the fact of organic evolution stands as the only scientific explanation of the origin, distribution and relationships of living things. The only problems of evolution at present in dispute among scientific men concern the methods and causes at work, and the only way in which such problems can be solved is by studying evolution as it is going on today.

I. THE MATERIALS OF EVOLUTION

Darwin recognized the truth of this and devoted much of his attention to the variations of animals and plants, since he regarded these variations as minor steps in the process of evolution. Such variations occur generally among wild and cultivated species and the extent to which they may go is shown by the various races of domestic animals and cultivated plants which have been produced under human guidance. Although all students of the subject have known that some variations are inherited and others not, that some are large and others small, it was not until the work of Bateson and deVries some thirty or forty years ago that the importance of these different forms of variations was fully recognized. DeVries especially demonstrated that inherited variations might be very great, so that an "elementary species" might be born in a day, and these variations be named "mutations," whereas all variations which are not inherited be called "fluctuations." Mutations may be great or small, but they are always inherited and consequently they are the materials with which evolution works, for any variation to be of evolutionary value must be inherited.

II. HOW DO MUTATIONS ARISE AND HOW ARE THEY INHERITED?

Older students of evolution focussed attention largely upon the transformations of mature organisms, for example the gross changes necessary to convert a cabbage into a cauliflower, a rock pigeon into a fantail, largely neglecting the microscopic and generally unseen stages which connect one generation with the next. We now know that the only living bonds between generations are the germ cells and any changes that are inherited must be represented in these cells; consequently the study of the methods and causes of evolution has been transferred from the changes occurring in mature organisms to the changes taking place in germ cells. These changes may effect the symmetry, pattern and constitution of the protoplasm of the egg cell, but a still earlier and more fundamental cause of change is found in the chromosomes of the nucleus, which contain the real "inheritance material." Therefore the study of the methods and causes of evolution resolves itself into an investigation of the changes taking place in chromosomes.

1. Cross-breeding or hybridization is an almost universal process, and it leads to many changes in the combination of chromosomes from different parents. The study of hybrids led to the epoch-making discovery of alternative inheritance by Mendel, and although he knew nothing of chromosomes, which were discovered, we now know that all the phenomena of Mendelian heredity depend upon the distribution of chromosomes to the germ cells and their combination at the time of the fertilization of the egg. In this way many new combinations of the materials of heredity are formed and many variations in the developed organisms that come from these new combinations of chromosomes. Bateson said that most of our domestic animals and cultivated plants are the results of deliberate crossings, and Lotzy maintains, contrary to the views of many biologists, that hybridization is the chief cause of evolution.

2. A second cause of mutation is found in abnormal numbers of chromosomes, also in the breaking in two of individual chromosomes and the reunion of the pieces in new combinations. These "chromosome mutations" are responsible for most of the mutations discovered by deVries in the evening primrose and by Blakeslee in the jimpson weed.

3. A more fundamental cause of mutation is found in the changes that take place in the genes or inheritance units, which lie in the chromosomes like beads on a string. Although these genes are so small that they can rarely if ever be seen even with the most powerful microscope, we have as clear evidence that they exist and occasionally undergo changes as that there are atoms and molecules which may also suffer changes. Such "gene mutations" are certainly an important factor of evolution and the manner in which they are caused is one of the leading problems of biology today. Recently it has been found that radium, X-rays and probably other forms of radiant energy may cause gene mutations and thus furnish the materials for evolution, and it seems probable, although it is still uncertain, that such mutations may be caused in still other ways.

III. CAUSES OF ADAPTATIONS

Mutations are certainly the raw materials of evolution, but how are these materials used? There is good reason to think that mutations occur in every possible direction; probably ninety-nine out of every hundred are injurious, perhaps not more than one in a thousand is distinctly advantageous. How then can we explain the fact that animals and

plants are so wonderfully well fitted to the places they occupy in nature? Consider the fitness of fishes, reptiles, birds and mammals for life in water; of birds for flying, of moles for burrowing, of deer for running; the fitness of all the organs of the body for their particular functions, of the eye for seeing, the ear for hearing, the nerves for conducting, the muscles for contracting. Indeed there is scarcely a structure or function of any living thing which does not show such fitness or adaptation, and the problem of the origin of such adaptations is today, as it has always been, the greatest problem of evolution.

There are two principal scientific hypotheses which attempt to explain these adaptations, known by the name of their chief proponents as Lamarckism and Darwinism. Lamarckism assumes that such adaptations are first acquired by mature organisms and then by some inconceivable process these acquired adaptations are transferred to the chromosomes and genes so as to become hereditary and reappear in succeeding generations. Many attempts have been made to find conclusive evidence of such inheritance of acquired adaptations, but so far without success. The Lamarckian doctrine is at variance with the best-established principles of genetics.

Darwinism, on the other hand, accepts the evidence of genetics that mutations occur in all possible directions and it undertakes to account for the fitness of organisms by the early death and elimination of the unfit. We know that many genes and combinations of genes are lethal and cause the early death of germ cells or of the organisms into which they develop. In nature injurious mutations are quickly eliminated, but at present we have no sufficient evidence that natural selection, or Darwinism, does explain all the marvellous adaptations of the living world. If to the natural elimination of unfit germ-cells or persons we add the intra-personal elimination of unfit reactions, we can explain a whole class of acquired fitness, but in so doing we introduce a quasi-psychic factor, as Darwin did in his hypothesis of sexual selection, and as many others have done from Aristotle down to the present time under the terms of "perfecting principle," "indwelling soul," " entelechy," etc. Such attempts to explain fitness by an appeal to psychism are speculations, not even working hypotheses, for no one has yet found a way of experimentally testing them. Multifarious variation and selective elimination are the best explanations of the origin of fitness that have ever yet been proposed.

How Did Plants Begin?

By G. L. WITTROCK

OBSERVING life in all its forms, we wonder as to its origin. We see animals and plants of all sorts, from one-celled individuals to very complex organisms containing billions of cells. Naturally we look for origins among the simpler, one-celled forms. Then we note that the animals feed on the plants, and that plants depend but incidentally upon the animals. This unbalanced relation at once suggests that the plants may have preceded the animals in evolution. But when we study the one-celled forms of both, we find ourselves confused, they are so much alike. It looks as though they originated together from a common beginning, and then diverged very early along two boldly distinct lines.

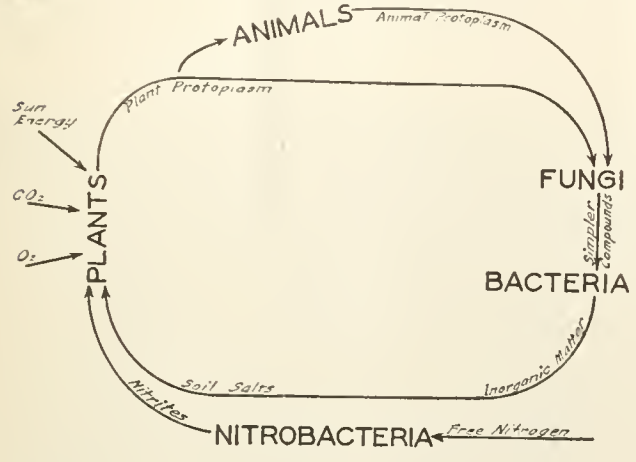
For plants and animals are alike in fundamental structures and functions. They are both built up of living cells composed of protoplasm, and perform the same life functions, respiring, feeding, growing and reproducing. But they have also taken to variant ways of life that have set distinctive marks upon each group.

The typical plant produces its own foodstuffs out of inorganic matter by a process using sunlight energy and called "photosynthesis," for which the green coloring matter "chlorophyll" is necessary. There are exceptions, such as the degenerate plants Indian Pipe and the fungi that have lost this power of primary food production which their ancestors must have possessed. But the typical plant draws its nourishment from the soil in which it is rooted, and spreads a green surface of body or leaves to absorb sunlight and carbon dioxide, all of which, together with water drawn through the roots, build up into foodstuffs packed with energy.

The animal takes those plant foods ready made. It has no power to produce its own foods and lives by consuming plants, either directly or by eating other animals that have eaten plants. That way of living demands movement, from one plant food supply to another, movement to capture or to escape other animals. Fundamental changes in structure result. The plants develop firm cell walls, usually of cellulose, mechanically rigid so the plant may stand erect in its fixed habitat. The cell walls of animal tissues, on the other hand, largely disappear, leaving the cells elastic for motion. The animals thus gain freedom of movement by becoming dependent on the plants. But the price is cheap, for movement brings contacts and problems, demands sensitivity and adjustive reactions, the beginnings of mind and eventual mastery of the world.

The chart shows the life cycle of plants complete,

while that of the animals is superimposed parasitically. But both plants and animals die, their bodies being decomposed into inorganic matter by fungi and bacteria. Fungi are evidently degenerate plants, but what are the bacteria? Are they plants or animals, or perhaps organisms more primitive than either, embodying characters of each? One group, the nitrobacteria, are both structurally and



The Cycle of Life

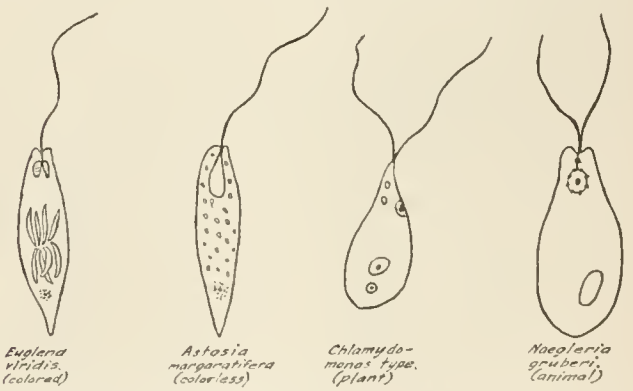
physiologically the simplest organisms we know and interrupt the organic cycle in a most suggestive way. They have the remarkable power of drawing free nitrogen from the air and decomposing carbon-dioxide without the aid of sunlight, making them even more independent than the plants. For the plants cannot use free nitrogen, but must get nitrogen in compounds in order to produce the proteins and protoplasm essential for life. The nitrobacteria are able to fix free nitrogen into these compounds upon which the plants depend. Really the plants are parasitic on these bacteria. Are the nitrobacteria then the original form of life, the common ancestors of plants and animals? Or must we look to those even simpler organisms, so far invisible, the filterable viruses recently discovered? We really do not know.

But our problem here is not the origin of life itself, but that of plants. This is really the problem of what group of organisms first used sunlight for food synthesis. The earliest plants probably lived in the water, for the simplest forms still live there, while the more complex are land forms. Between them are mosses and ferns, amphibious in the sense that they live their lives on land, yet depend on water to carry their male sperm cells during fertilization. Turning to the water, we find a most suggestive primitive group, the Flagellates, named after the flagella at their head ends, whip-like hairs lashed back and forth in swimming.

There are two kinds; those with and those without green or other colored chromatophores. Those with chromatophores can produce their own food like plants, seem to be related to the green algae and resemble the free swimming reproductive cells of many low green plants. The colorless flagellates, on the other hand, show a close structual likeness to cells of such low animals as the protozoa. The flagellates may therefore represent the primitive type from which have evolved both colorless animal forms and green plants. The green flagellates actually do tend to approach the non-motile condition of typical plants, while the colorless forms require greater power of movement to go with their animal method of food getting.

Without definitely calling them plants, botanists consider the flagellates a sort of substratum for the true plants because they approach them in several ways. (1) They have a structure similar to the lowest algae, being motile, more or less oval, with a solid protoplasmic body, a central nucleus, a specialized head end with one or more whip-hairs, and a contractile vacuole. However, the cell walls are unlike those of both plants and animals, being a dead mucilaginous envelope. Also no starch is found, the chromatophores are usually discoid and and the cell walls permit amoeboid movements unusual in plants. (2) The vegetative division occurs during the motile state and is always longitudinal, a slow constriction into two halves beginning at the fore end, just as in lower plants. (3) Like the lower algae, the resting cells are formed vegetatively by a curling and contraction of the cell contents, the walls remaining as transparent shells. There is as yet no sexual reproduction.

For the present, it seems likely that the Flagellates are the primitive stock from which plants originated. Plants may have sprung from some other primitive organisms, or the photosynthetic method may have originated independently in several groups.



Suggestive likenesses between flagellates and simple plants and animals.

The blue-green algae, for instance, are like bacteria in the splitting nature of their multiplication, and are either immotile or slightly oscillating. They seem, however, to bear little relation to other plants, though their color indicates they function as plants. Altogether, the flagellates seem to be an ancestral group from which both animals and plants may have sprung. But at best this is speculation, and more facts are needed for definite knowledge.

The Man Ape of Taungs

By ALLAN STRONG BROMS

THE right man in the right place at the right time." Dr. Raymond A. Dart, Professor of Anatomy at the University of the Witwatersrand of South Africa in the fall of 1924. He had come prepared to tackle the problem of man's origin, bringing from University College, London, a whole series of brain casts of apes and extinct human types, and with his mind full of Darwin's prediction of 1871 that as the "African Apes present the nearest likeness to Man in structure and ability, it is somewhat more probable that our early progenitors lived on the African continent than elsewhere."

Dr. Dart's enthusiasm had aroused his students and colleagues to a wide search for human and related fossils, and so it was Dr. R. B. Young, the Professor of Geology, who in November, 1924 actually found in a cave at Taungs the fragments of rock which disclosed bits of bones and what seemer to be a natural cast of a brain case. But it was Dr. Dart who put in the months of skilful and delicate work clearing off the fragile bones and fitting them to the brain cast to restore the form of head and face, and who then identified in them a young super-ape hinting at a South African origin for Man himself. For this four or five year old youngster (its age being revealed by its milk teeth) had a brain too big for an ordinary ape, yet too small for a human infant of its age. Other features further enforced the suspicion that another important missing link in man's ancestry had been found. As there was obviously a thrilling story here, Dr. Dart went over the ground most carefully to read it rightly and interpret it fully. Also he gave his ape a name, Australopithecus africanus, which means simply the Southern Ape of Africa.

Taungs is eighty-five miles due north of Kimberly, the famous diamond town, and on the main line of the Cape to Cairo Railway. To the northwest stretches the wide Kalahari Desert and everywhere else are dry plains with very few trees. Fifteen hundred miles to the north the Congo jungle begins, the present home of the Gorilla and Chimpanzee, nearest to man of the living apes. Between is the wide barrier of treeless plain which no ape can cross. Furthermore, the geologists tell us it has been so for untold ages.

But how did this ape of Taungs ever get so far? Because he was more than just ape. He was developing human capacities and adaptabilities. His kind were probably slighter than the African apes we know, but more wiry, alert and inventive. Otherwise they would never have ventured out of the protecting jungle nor managed to survive in the open and therefore dangerous plains country. Dr. Dart is fully persuaded that on this scene the ape tribe of Taungs adventured on to become Man. He states most persuasively:—

"In order to achieve his so-called erect posture and terrestrial mode of life, the monkey that was to be man had to pass through a severe apprenticeship of . . . two initiatory phases before he entered the . . . true freemasonary of manhood. These two phases were firstly, the semi-arboreal typified by the living anthropoid ape; secondly, the entirely terrestrial man-ape phase. . . . The second phase has been appreciated only as a theoretical necessity, and the scene of its occurence has been purely a matter of conjecture. The Taungs remains show that this second phase was a living reality; . . that the anthropoid achieved human status by laborious passage through the terrestrial man-ape phase; finally they indicate, if they do not actually prove, the quarter of the earth upon which this penultimate act in the drama of humanity was staged. . . .

Man-Ape of Taungs, right side view of skull
From Natural History

"There is no woodland approach to Taungs from the north, east, or west. This open and in large part barren country, interposed between the tropical forest and Taungs is, and has been from Cretaceous times, an effective barrier against the migration of the semi-arboreal anthropoids. . . It is obvious . . . that the . . . group which forced this barrier into the remote Southland had evolved an intelligence (to find and subsist upon new types of food and to avoid the dangers and enemies of the open plain) as well as a bodily structure(for sudden and swift bipedal movement, to elude capture)

far in advance of the slothful, semi-arboreal, quadrupedal anthropoids. They had thus attained a degree of physical and psychical advancement that sundered them irrevocably from their tropical cousins.

"The factors which evoked the thinking and planning powers of the anthropoid and . . . caused the transformation from anthropoid to man, are to be sought . . . in steadily and continuously operating environmental conditions which constantly and increasingly demanded the operation of choice and

Restoration of Taungs Man-Ape by Forestier
From Natural History

cunning. Such an environment is certainly not to be found in any land belt containing the easy refuge of trees. . . . Just as for the expansion of the brain so, for the evolution of a more erect posture, . . it was essential that a large territory should be available to make it impossible to return to the forest. In this way the anthropoid group should be committed over a countless number of years to use their upper limbs for fight and their lower limbs for flight. An environment of this type was present, because of the barrier already mentioned, from Cretaceous times onward in Southern Africa; and Southern Africa is the only country which has elicited an anthropoid individual betraying features such as one might expect to result from the operation of these unremitting and compelling environmental conditions."

The scientific authorities are agreed that the Taungs ape is really an ape, with distinct leanings towards human kind. Thus Professor W. J. Sollas states that "Australopithecus is doubtless generically distinct from all known Apes, and in those important characters by which it differs from them it makes a nearer approach to the Hominidae" (mankind). Similarly, G. Elliot Smith states that "this Ape, which like Man may have been emancipated from the necessity of living in forests, seems to reveal definite evidence of nearer kinship with Man's ancestors than any other Ape presents." Dr. William K. Gregory refers to it as "a young anthropoid with an exceptionally well developed brain. While it may be nearer to the chinpanzee than to man, its brain, skull and teeth tend to bridge the gap between the highest apes and the lowest men."

Unfortunately, there is much doubt as to the geologic age of the remains, some arguing that they could have been quite recent. But Dr. Dart, with others who have gone over the ground carefully, is fully convinced of its great age, perhaps old enough to have figured in the man-ape ancestry of mankind.

They were associated with the remains of two extinct species of baboons. As, for some time, life has been more static in Africa than in the North this probably means a respectable antiquity, perhaps even suggesting Pliocene age.

However, the scientists are by no means agreed that Man originated in South Africa. To begin with, the fossil ape-man of Java, typifying the next upward stage in human development, was found across the Indian Ocean more than five thousand miles from South Africa. Furthermore, mankind seems to have dispersed from central or southern Asia, where open plains also abounded far back into geologic times and where numerous fossil apes (though of lesser brain volume) have been found. The scientists are mentally torn between the two continents, with much reason on each side. In either case, both man-ape and ape-man probably wandered widely, so that almost anywhere in these parts of the world we may find new links in the ancestry, perhaps even the clue to man's origin and wanderings. At least the search is hopefullly on.

New Evidence on Close Relationship of Men and Monkeys

Professor Hegner of Johns Hopkins finds that protozoa parasites of monkeys and men are the only ones capable of living in the bodies of either according to the April 12th issue of **Science**, which quotes him as follows:

"In very few instances are species of protozoa that live in one species of animal capable of living in another species of animal, no matter how close the relationship. The situation as regards monkeys and men is strikingly different. . . . There are a few protozoa that occur in man that do not have representatives among monkeys and a few in monkeys that have not been reported from man, but most of the human protozoa have representatives in monkeys indistinguishable from them. This is in such striking contrast to what we know to be true of the protozoan parasites of other animals, we must recognize a genetic relationship between monkeys and men. That is, the protozoan parasites of monkeys and men have descended from protozoa that lived in the ancestors of monkeys and men and that had the SAME ancestors. Our studies of these parasites of monkeys and men add a type of evidence that makes it even more certain that our remote ancestors were arboreal monkeys."

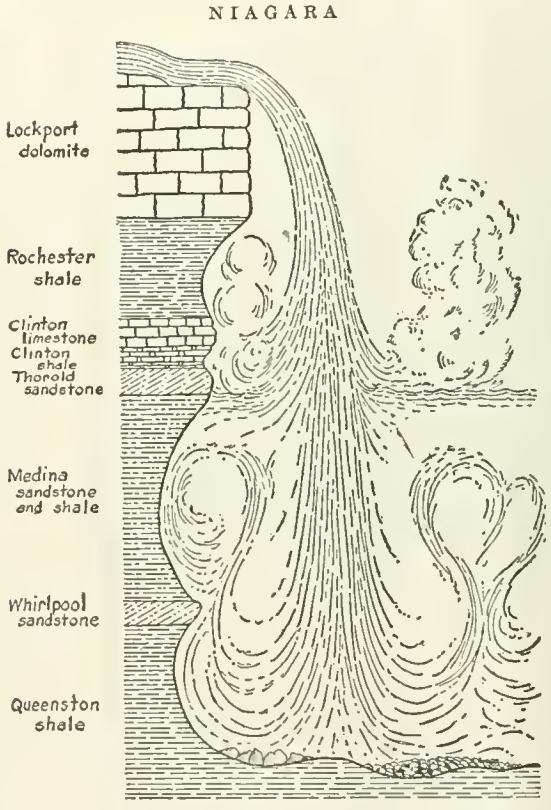
The Story of Niagara

THE seven mile gorge below Niagara Falls has been dug by the tumbling waters undercutting the hard capping rocks making the cataract crest. Underneath are softer rock layers that yield and wear away in the powerful swirl of the plunge basin, thus undermining the harder top layers until great blocks fall from the overhanging ledge for want of support. These blocks, swept around by the mighty whirlpool of the falls, arm the water with effective cutting tools that dig the more swiftly into the rocks below. Thus the falls cut their way backwards, slowly receding upstream.

Several factors have altered the rate and depth of gorge cutting, the chief of which are changes in the volume of the river itself. Because the river is fed by the Great Lakes to the West, its changing volume echoes the events in the development of those lakes during and after the melting away of the great ice sheets which covered their basin during the last glacial period. As the ice edge slowly receded, it progressively uncovered the lake basins, shifted their drainage outlets, and otherwise modified the volume of water and the falls recession.

When the ice sheet first melted back from the Niagara region, no falls appeared, for the Ontario waters were high and flooded the area, being banked on the north by the ice itself and draining southwest through the Erie basin towards the Mississippi. But when the ice uncovered a lower drainage outlet to the east along the Mohawk and Hudson rivers, the Ontario waters sank, leaving the high embankment over which the Niagara waters tumbled. At first, a temporary Lake Tonawanda formed just back of the embankment edge, discharging by five spillways. Of these, the Lewiston spillway was lowered by erosion most vigorously, so that it soon robbed the others of their waters, concentrating the whole discharge and gorge cutting to the Niagara River.

During the ensuing first stage of gorge cutting, only a portion of the Great Lakes drainage came through Niagara, for lakes Superior and Michigan were cut off by the banking ice and discharged by way of the Mississippi. But the waters from Lake Erie and that portion of Lake Huron from which



Sectional View of Horseshoe Fall
After Gilbert

the ice had melted did give Niagara a volume about 25 percent of the present. But because the rock layers slope slightly upward to the north, the fall was nearly twice as high and so cut deeply for some two thousand feet upstream.

America

A second stage b
uncovered a low ea
per Great Lakes a
Canada. This rol
the Erie waters, le
of the present volu
and an eighth, the
persistent, the res
narrower and shal
the turbulent char
stream.

But the land to
heaving upward in
sheets melted off.
Trent outlet so hi
send the upper lal
the Erie basin and
But also there was
outlet at Rome, N
the Ontario waters
thus raised until th
gorge to the foot
deep digging thro
Whirlpool Sandsto
gorge was therefor
not deep, though t
a narrow channel t
bed. But present
uncovered the St.
waters of Lake On
abandoning the R
to Niagara its hig
its gorge deep onc

Panoramic Winter View of Niagara Falls from Canadian Side of Goorge

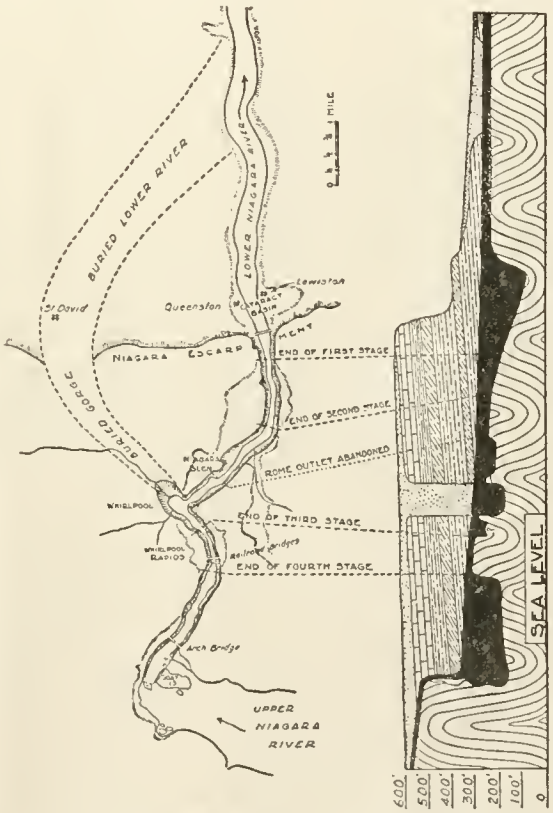
lls Goat Island Horseshoe Fall

Panoramic Summer View of Niagara Falls from Canadian Side of Gorge

when the ice retreat
rd outlet for the up-
the Trent River of
Niagara of all but
g a mere 15 percent
So for the next mile
ing was slow though
g gorge being both
r, now evident from
r of the constricted

north and east was
ef as the heavy ice
effect was to lift the
is to cut it off and
aters again through
r the Niagara brink.
plift of the Mohawk
York, through which
ned. Their level was
cked up the Niagara
e fall and prevented
the rather resistant
This portion of the
wide, but originally
iver has since rasped
gh the old sandstone
e receding ice sheet
rence valley and the
again fell, of course
outlet and restoring
unging falls, cutting
re.

During this third stage the Whirlpool was formed. In pre-glacial times, a river had flowed across this region toward St. David. It too had a great waterfall that had cut its gorge upstream as far as the present Whirlpool. But the last ice invasion had buried this gorge under a mass of clay and gravel. Once the receding Niagara Falls reached this ancient gorge, it swiftly cleared out the softer filling in its path, leaving the deep Whirlpool basin.



Sketch Map of Niagara Gorge
Depth of water shown in black
Kindle and Taylor

The fourth stage began when the receding ice sheet uncovered a low outlet for the upper Great Lakes by way of the Ottawa River of Canada, again robbing Niagara of all but the Erie waters. The weakened falls cut only a shallow and narrow gorge and could not even sweep away the boulders fallen from its brink. So today, the water rushes through this encumbered and constricted channel as the furiously tumbling Whirlpool Rapids.

Finally the present stage was inaugurated by a further uplift of the land to the north, cutting off the Ottawa outlet and again sending the Great Lakes waters by way of Erie and Niagara. The restored falls then began to cut the present deep upper gorge. An angle in the river bed permitted the recent splitting of the falls into the American and Canadian falls, with Goat Island between. Much the greater volume of water flows over the Canadian falls which are therefore receding rapidly, the American falls being too feeble to remove the rock debris at its base, which prevents the undermining necessary for speedy recession. The face between the two falls is therefore very unequal and the time is coming when the Canadian Falls, receding past the head of Goat Island, will cut off all water from the American side, leaving the dry upper river channel and abandoned fall scarp.

A similar event occurred during the third recession stage at Niagara Glen, its abandoned fall scarp and upper river channel being however on the Canadian side. Here one may wander through the dry river above and among the boulders strewing the gorge below the precipitous brink of a once mighty waterfall.

It will be seen that Niagara has had an eventful development and that changes of volume quite prevent us from using the present recession rate of four feet per year to estimate the age of the falls themselves and the dates of the ice sheet retreat. But careful consideration of the factors involved and other quite independent data lead us to estimate a total age of between 30,000 and 35,000 years for the falls since they started from the Lewiston brink.

Reference: The Falls of Niagara, Glenn C. Forrester, N. Y. 1928.

Fundamentalist Follies

In this Monthly Feature EDWIN TENNEY BREWSTER will refute all fundamentalist objections to evolution.

AMONG the most aggressive of Anti-evolution magazines ranks **Defender,** organ of Winrod, Revivalist. Its motto is "Back to the Bible." But it dabbles also in natural science.

Thus, for example (July, 1929, p. 14)

"Time after time sedimentary strata which are alleged to be very old lie smoothly and seemingly undisturbed on top of rock, likewise undisturbed, which is alleged to be much younger. I could cite instance after instance of this."

The same notion appears widely in Fundamentalist writings—as for example in Reverend Chester K. Lehman's little book, **The Inadequacy of Evolution as a World View (pages 14-15)** and in the debate in New York early in 1924, between the late John Roach Straton, D. D. and Charles Francis Potter. But all such rest on the authority of one George McCready Price, teacher of a wide variety of subjects in an equally wide range of Second Advent schools, and a prolific writer for the last quarter century on scientific topics, though he himself appears to have no scientific training whatever.

Doubtless, therefore, one "could cite instance after instance"—from the writings of clergymen and of Fundamentalist laymen who write for denominational journals attacking evolution. But the queer thing about these alleged instances of undisturbed rocks in the wrong order is that no geologist has ever seen a single one of them. They occur innumerably in sermons—but no working geologist, accustomed to looking at real rocks, has ever discovered anything of the sort.

What geologists do find is always precisely what they have been finding from the first beginnings of geologic science: The strata of mountain districts are wont to be broken and twisted and shoved about and even sometimes turned completely upside down—as anybody can see for himself, just keeping his eyes open in a rough country. Where the strata are flat and in place, just as when they were first laid down under water, then the district is a level country and no proper mountains; and every single layer is precisely where it ought to be on evolutionary grounds.

Broken rocks, then, in mountain country, may exhibit all sorts of visible dislocations—that is, in fact, precisely what make mountains. Among other dislocations, one sees places where one mass of rock has been pushed sideways over another.

This is not a matter of theory. Anybody can see it. There is a crack, an inch or two wide or a foot or two, commonly filled with broken rock—the "fault breccia" of geologists—and always with the surfaces that have slipped over one another smooth ed and polished like a mirror," as one geologist describes the great overthrust at Chief Mountain, Montana, that is a special bone of contention in the Fundamentalist press. But one does not need to travel to Montana. One sees these "overthrusts," in the right sort of country, sometimes a half-dozen in a single cliff. Nearly always, one can run his hand over the "slickensided" surface where the rocks have slid, and make out which way the fault has gone by the fact that the rubbed surface is smoother in one direction than in the other, like a cat's fur. All this, on a small scale, anybody can see.

Necessarily then, where great sheets of rocks have been sliding over one another, it must often happen that an older stratum is shoved up over a younger one. Fundamentalists, following Price, make great play with this. "Strata which are alleged to be very old do undoubtedly often lie on top of rock" which is alleged to be much younger.

But not "smoothly and seemingly undisturbed!" That part is pure invention of the Fundamentalist. Anybody can see the crack. Anybody can run his hand over the polished surface where the rocks have slid. But, of course, if one refuses to look and will not touch, then naturally he will not see and feel. And what the Fundamentalist has not seen and felt, he insists is not there!

So we have this extraordinary situation. Professional geologists by the hundred have examined these localities where old rocks lie on top of younger ones. They report having located the "fault" where the upper rock mass has slid up over what is really younger strata. But that doesn't suit Fundamentalist dogma. So Fundamentalists deny the facts. They have not seen any fault. Isn't their testimony just as good as that of the geologists?

All geologists, in short, testify that they have seen something. Many Fundamentalists testify that they have not seen it.

For my part, I believe them both.

BRYAN UNIVERSITY, Dayton, Tennessee is to open its doors in September as a fundamentalist monument to the great anti-evolution champion. Remember the fate of that other "fundamentalist university" at Des Moines?

ANOTHER LIE NAILED

The Rocky Mountain News reported a Catholic Lenten sermon as follows:

"Father McMenamin recounted the story of the skull of the original 'Java Man,' which eventually turned out to be the knee of an extinct elephant. 'Just think' he explained, 'we came near hanging the picture of an extinct elephants knee in the gallery of our ancestors."

Mr. Whitenack, secretary of the Colorado Rationalist Association, immediately wrote the good Father:

"Such ignorance places you in the class with such clerical falsifiers as Rev. W. B. Riley, Dr. Arthur I. Brown and Prof. George McCready Price. The skull of the 'original Java Man' was found in 1895 by Dr. Dubois whose son is now living in Denver. That it is the fossil of a very primitive man who lived at least a million years ago has not been questioned by any scientist for a quarter of a century.

"The elephant's knee, with which you fooled your audience and sought to discredit the work of HONEST men, was found a few years ago near where the Java skull was discovered. At first, in an incompetent and sensational news report, it was called a fragment of human skull. Had it been found near Mount Arrarat by the clergy it would, no doubt, have been mistaken for the skull of Noah and highly prized as a relic of the Church before which people would be cured of all manner of diseases. But upon careful examination by an HONEST scientist the fragment was easily identified as part of an elephant's humerus."

THE WORLD FAIR in Chicago in 1933 is to be the greatest scientific exposition ever held. Its keynote will be "The Century of Science" under direction of the country's most eminent scientists. A large number of International and National scientific congresses will be held there.

AN APE FARM of 200 acres is being established in Florida by Yale University where a special study will be made of the habits, social relations, life history and psycho-biological development of the anthropoid apes in their relation to man under the direction of Professor Robert M. Yerkes.

PRIZES OF FROM $50 TO $200 worth of books are offered by the Committee on The Place of Science in Education of the American Association for The Advancement of Science to the libraries of secondary schools whose students produce the best essays on a specified list of subjects. Details may be secured from Otis W. Caldwell, Chairman, 433 West 123rd Str. New York City.

NEW BOOKS

THE EARTH—ITS ORIGIN, HISTORY, AND PHYSICAL CONSTITUTION by Harold Jeffreys. 2nd Ed. New York, The Macmillan Co. and The Cambridge Press, $6.50. 399 pages.

There exist today only two widely accepted theories of the origin of the solar system, and hence of our earth—the Planetesimal Hypothesis of the late Dr. T. C. Chamberlin and Prof. F. R. Moulton, both of the University of Chicago; and the Tidal Theory of Sir J. H. Jeans and Dr. Harold Jeffreys. In the past it has seemed to many scientists on this side of the Atlantic that these two great English thinkers had ignored unduly the researches of Professors Chamberlin and Moulton, although it was considered that the Tidal Theory was largely an outgrowth of the theories developed by the Chicago scientists.

Fortunately, in this new and revised edition of his great work, "The Earth," Jeffreys has removed this objection. In an appendix, he considers the Planetesimal Hypothesis fully and fairly, referring to it as "the parent of the Tidal Theory," though adversely comparing it with Jeans' hypothesis, Which, he remarks, "bears a close resemblance to mine, the agreement becoming striking since the two methods of attack are quite different." It thus becomes apparent that the Tidal Theory is no isolated hypothesis, but is a legitimate outgrowth of and advance upon the Planetesimal Hypothesis, just as this, in a sense, grew out of a critical examination of Laplace's now discredited "Rotational" Nebular Hypothesis. In both of the modern theories it is accepted as substantially established that the sun was broken up by a passing star, several times more massive than itself. There is, as Jeffreys states, a general resemblance between the modes of formation and rupture of the filament or filaments, ejected from the sun, in the two theories. It is with the Chamberlin-Moulton "planetesimals" that the break between the two hypotheses occurs, and with the "planetesimal" contention that the planets grew gradually larger by accretion of these meteoritic bodies.

On the problem of the origin of the moon, Jeffreys has made certain changes since the first edition of his book in 1926. It was then assumed that the sun at the time of the assumed disruption was greatly distended—almost filling the orbit of Mercury—hence below the density required. If the primitive sun had nearly its present density, tidal disruption of the liquid earth was possible, and the moon could have been thrown off as a separate body by the action of the solar tides—as suggested, in 1879, by Sir George Darwin. This is more nearly in harmony with the now known data than any alternative theory—e. g., that the moon was an independent planet, subsequently "captured" by the earth. Jeffreys has, in this second edition, come to accept it as highly probable that, as was first suggested by Osmond Fisher, the Pacific Ocean fills "the scar left when the moon was formed."

The various methoods of estimating the age of the earth are discussed by Jeffreys. His general conclusion is that by far the most satisfactory data are to be derived from ascertaining the ratio of the quantities of uranium and lead in any series of igneous rocks, the rate of degeneration of uranium to lead being now known to follow what appears to be an unvarying law. Radium occurs in nature only in the presence of uranium, which itself never occurs without radium. Knowing the rate of breakup of uranium into its final product, lead, it is a simple matter to find the time since the formation of any rock if we know the amounts of uranium and of lead in any given specimen. Jeffreys concludes that the lower limit to the age of the earth obtained by stndying individual minerals, and the upper limit given by the constitution of the crust as a whole, are sufficiently close together to fix the age as roughly two thousand million years.

Very interesting and convenient is Dr Jeffreys' summation and critical examination of current theories of the causes of climate variation and the causes of glacial epochs. "We are now in a glacial period, although not at its height." Several factors admittedly are involved, but it appears that Brooks' theory is most probable, that land submersion, with consequent extension of oceanic conditions, accounts quantitatively for the epochs of mild climate, while general elevation of the land tends to the production of extensive ice sheets. When we add to this the important contribution of F. Kerner-Marilaun, in which he shows that a rise of temperatnre of two degrees would clear the Artic Ocean completely of ice, thus abolishing the effects of floating ice and cold currents, both long spells of mild climate and the much shorter periods of glaciation are largely, if not adequately, explained.

Dr. Jeffreys brings against Wegener's theory of floating continents what appear to be devastating criticisms. But he finds no facts regarding ancient land bridges between the Old and the New World which are incompatible with the results of his own researches, though he does not actively advocate the reality of such submerged land connections, for the reason that he is "not yet convinced of the cogency of the palentological evidence."

There follows what I cannot but regard as a decidely surprising statement; namely, the conclusion that

> the species concerned are plants and low animals, and it seems far from impossible that spores, seeds, or eggs could have drifted across (from continent to continent) on floating refuse.

But we know that early in the Eocene—Old World mammals (not "low animals") appeared as immigrants in North America, while early in the succeeding Oligocene epoch, a still more marked invasion occurred, although the time was of short duration. A third extensive migration of higher mammals took place in the Miocene, and a fourth during the Pliocene. Inasmuch as there is no paleontologist living today who doubts that the various species of rhinoceros (to give only one example) which appeared in North America during Miocene times were of Old World origin, one wonders just what Jeffreys means by suggesting that only "low forms" that might have drifted across the ocean "on floating refuse" have to be accounted for.

But Dr. Jeffreys does not pretend to be a palaeontologist: he may rest well content with the distinction of being one of the world's foremost geophysicists, and the author of what many experts regard as one of the best works that has so far appeared in the English language on the origin, history and physical constitution of the earth. MAYNARD SHIPLEY

RECEIVED FOR REVIEW

DUST TO LIFE: Burton Peter Thom
THE UNIVERSE AROUND US: Sir James Jeans.
THE STORY OF EVOLUTION: Benj. C. Gruenberg
HUMAN HISTORY: G. Elliot Smith
NEW VIEWS OF EVOLUTION: G. P. Conger
BIOLOGICAL BASIS OF HUMAN NATURE: H. S. Jennings
THE CHILD'S HEREDITY: Paul Popenoe

(*Continued from page 4*)

cargo of genes, because its structure and activities are limited and regulated in various ways through the mutual influences received from the other cells in the body. The various cells of different organs developed differently from one another because, though possessing the same genes, they found themselves in different influences, from the start. Only the germ-cells, then, may eventually realize anything like their full potentialities.

How We Differ From One Another

All this explanation, somewhat off the main theme, may serve to furnish some sort of notion of how the characteristics, in fact the entire substance, of any human or other living being depend upon its genes, acting in a chemically coordinated fashion. So complicated is the manner in which the products of the different genes react with one another that no final product and no characteristic of the adult body is due to any one specific gene, but in the production of every organ, tissue or characteristic, numerous genes take part. Nevertheless, if one individual differs from another individual in regard to just one of the genes that do take part, it will be seen that the given characteristic in the two individuals will be different, and so, conversely, a difference between two individuals in regard to a certain characteristic, let us say eye color, may be due to a difference between just two given genes in them rather than other genes.

By studying the characteristics that appear among the descendants in later generations, after individuals differing in regard to one or more genes have crossed together, the definite Mendelian laws and the laws of linkage governing the inheritance of genes have been determined, and they are found to have a practically universal validity. There is no use attempting here to formulate in detail these rules and their working out; this usually occupies the major portion of a course in genetics. It is sufficient to call attention to a few pertinent facts.

When two germ-cells that differ in respect to a certain gene, *e.g.*, the egg having the gene for brown and the sperm that for blue eyes, fertilize each other, neither gene is lost, but the resulting individual possesses both genes in every one of his cells, even though his eyes may show preponderantly the brown color, brown being said to be the dominant gene and blue the recessive. Half the germ-cells formed by an individual of such mixed composition will carry the brown gene and not the blue one, the rest carry the blue gene and not the brown, and so there is as good a chance for any one of his children to inherit the blue gene as the brown one. Moreover, it is found that neither the blue gene nor the brown one, when inherited by the next generation, shows any weakening or other trace of its former sojourn with a gene of opposite character. It persists through the generations uncontaminated by its associate-genes.

Now if the individual of dual composition had also been dual in regard to some other kind of gene, say for hair shape, having received the gene for curly hair from the parent that gave him brown eyes, and the parent that donated to him the gene for blue eyes, then, although he would probably show moderately curly hair, nevertheless, as in the case of the eye colors, half of the germ-cells which he produced would carry curly and the rest would carry straight. However—and here lies the important point—not all those germ-cells of his that carried brown would be the ones carrying curly, nor would all those carrying blue carry straight; there would be some carrying the combination, new perhaps for this family, of brown eyes with straight hair, and other germ-cells carrying the converse new combinations—blue eyes with curly hair. Thus, by crossing and recrossing individuals with different genes will be produced in subsequent generations until all possible combinations of the differing genes in crossable individuals have been given a trial. Occasionally totally new effects, new characteristics, are thereby produced, when some new combination is obtained through the unexpected interaction of genes which never before had been tried out together, but such cases are rare. Were the process just described the only method of obtaining change in the characteristics of organisms, evolution would soon reach its limit.

How Species Arise

On analyzing the results of various crosses, it is found, as might have been expected, that closely related individuals differ in more genes (in fact, in about twice as many as do brothers or sisters), individuals of different races differ in still more genes, and those of different species, where the crosses can be made and analyzed, are found to differ in a yet greater number. In each case, however, the differences are of the same general nature —differences in ordinary genes in the chromosomes, that normally are handed down in heredity in the orthodox Mendelian fashion. In fact, in some cases, as Baur and others have found, the difference between two members of a family may be in regard to the very genes which also distinguish two different species as a whole. The species-differences then, are simply more abundant, and have had a chance to become more select(ed). And same is true of the differences between more widely separated groups (with the further proviso, that the number and arrangement of the genes, as well as their kind, may be different). For, in the course of evolution, as one species changed into another and then again into another, it would gradually diverge so far from its progenitors as to be placeable in a separate genus, then in a separate family, order, class, etc., although all along differences would be accruing in the same manner as before. If they can accrue in any other manner we should by this time have gotten evidence of it.

Most of modern genetics has been occupied with tracing down the above "facts." They relate essentially to the method of transmission, to later generations, of gene-differences that are already found to exist between individuals. They show the universality of these differences, their comparative capabilities. But they leave untouched what now becomes the major question—how do such differences originate in the first place? What is the origin of variations?

A hitherto rather incidental, yet very important, part of modern genetics has had to do with the problem just raised. It has been discovered definitely that differences between genes do arise, *de novo*, as it were. That is, not all gene-differences now existing in a population have existed in it from the beginning. New differences are continually arising, somehow, and the differences now existing have undoubtedly arisen in the past in a manner similar to these.

Where Variations Begin

Each gene-difference arises suddenly and full-fledged, though we may not be aware of it at once. Thus, in a population of gray-colored mice, suddenly, in a certain cell of one individual, one of the genes whose cooperation is necessary for the production of the gray color undergoes a change into a gene of different composition that tends, in its interaction with the other (unchanged) genes for color, to produce a yellow tinge instead of a gray. In this single cell, however, the change will not be observed by us. But if this cell, or one of the cells derived from it, happens to be a germ-cell, an offspring-individual may be formed in the next generation all of whose cells carry this new gene. Then if the new gene is dominant (as it happens to be in the case of yellow *versus* gray in mice) to the old gene for gray which the offspring has received from its other parent, the coat of the new animal will be yellow, and we will see that a mutation has occurred. But if the new gene had been recessive, the gray dominant, the offspring would have appeared gray like its parents and we should not yet have been aware of the mutation. The new gene might persist none-the-less, and be inherited by generation after generation in invisible fashion, being meanwhile "dominated over" by the gray from the other parent. If in a later generation two descendants both of which carried the mutated gene happened to mate together, an egg with the yellow might become fertilized by a sperm also carrying yellow, neither, therefore, carrying the dominant gray, and from such a union a visibly yellow offspring would emerge for the first time. A mutation, when recessive, may accordingly fail to manifest itself for many generations, or may never have a chance to show itself at all, before the line of individuals carrying it becomes extinguished. (It has been shown by Fisher that most mutations must meet this mute inglorious fate.)

The new gene, once it has arisen, is ordinarily as stable as the old. The change is definite and fixed, evidently of a chemical nature. Once it has occurred, we have a new mutant gene which will eventually either spread throughout the population or be killed off, according to whether the individuals which carry it reproduce more offspring or fewer.

The effects of mutations are of course as varied as the gene-differences which are found to occur within populations, since these gene-differences originated by mutation. Some gene-differences, some mutations, produce large and startling effects, like growing a leg on a fly's forehead. Some affect the whole body in practically all its parts, others apparently but one. But the less conspicuous changes, the insignificant effects that are easily overlooked, or that even, in many individuals, quite overlap the normal type, seem at least as apt to occur as do the pyrotechnical varieties. Evidence is not lacking that physiological changes, and changes that can only be detected physiochemically, are probably as frequent as changes in visible structures, but geneticists have till now had to have a predominantly morphological training, and anyhow the morphological is easier to see and deal with. It would be absurd and scholastic to try to classify mutations according to the nature of their effects. A mutation can do practically anything that life can do—or at least a little of it, for life is built out of mutations.

IV. THE RANDOMNESS OF MUTATIONS

The statement just made does not necessarily mean, however, that the average mutation does very much in the furthering of life. You will recall that perhaps the biggest question among the older schools of evolutionists was this: Do variations have a tendency to be adaptive, to further life? Is there any evidence in them of an internal or external adapting or perfecting principle, call it what you will? Any kind of inheritance of acquired adaptation of the germ-plasm to environment, or single-stepping origination of species requires this. What do the data on the actual occurrence of mutations show?

They show just the opposite, and in so doing they support Darwin. The vast majority of observed mutations are positively detrimental, and handicap the individual less or more in the struggle for its survival and reproduction. In fact, as Altenburg and I showed in some studies on the fruit-fly, *Drosophila*, in 1919, by far the greater number of detectable mutations in it are actually lethal: their effect is to kill the animal before it becomes adult (though of course their effect may be prevented if they are recessive and if the dominant normal gene has been received by the individual from its other parent). Evidence is accumulating that the same situation probably holds in other forms of life. Now this is just what we should expect, and did expect, on the basis of the theory that a mutation is a chemical change in a gene, occurring at ran-

dom, as it were—that is, without reference to the effect that would be produced, a-teleologically. Suppose you prod the innards of a watch at random—bring about some alteration in ignorance of the effect it may have. Are you likely to make it a better-running watch? A change, purely accidental in this sense, wrought in any complicated organization is more likely to injure or wreck than to improve that organization for the specific function (in the case of life, multiplication) which it subserves. But, unless the organization has reached its absolute maximum of efficiency already, there will still remain *some* changes, and therefore *some random* changes, that will help. And so, occasionally, when your watch has stopped or is running poorly, you may knock it, prod it, or drop it, and find that, by the lucky replacement of a cog, or the displacement of a sand grain, it starts up merrily again. We shall return to this topic later. Meanwhile, we stand on our data: despite the staggering complexity of adaptation in living things, the vast majority of mutations are, as is to be expected, anti-adaptive.

What Causes Mutations?

It will not suffice, however, simply to call the changes "accidental." An accident is something whose cause was independent of something else you are interested in, but every accident has its cause just the same. And so we return again to our perennial question: What is the cause of mutations? Evidently, we may now say, not any outer or inner tendency toward perfection of the life force, but that does not help us very much, scientifically. The mutations whose origination has been known to geneticists have been on the whole very scattered and sporadic, so that little of definite information could be obtained, by collecting these observations concerning the conditions which may have been contributory to their occurrence. The trouble was that mutations having a conspicuous visible effect are so very rare anyway that one does not find enough in any one experiment to "count." However, the very negativeness of this result, and the varied character of the mutations as they did occur, suggested that their occurrence had little or no relation to the ordinary variables of the environment.

Efforts have been by no means lacking, on the part of numerous investigators, to find the cause, or a cause, of visible mutations, by trying all sorts of maltreatments in the attempts to produce such changes. In the course of this work, animals and plants have been drugged, poisoned, intoxicated, etherized, illuminated, kept in darkness, half-smothered, painted inside and out, whirled round and round, shaken violently, vaccinated, mutilated, educated and berated with everything except affection, from generation to generation But their genes seemed to remain oblivious, and they could not be distracted into making an obvious mistake in the reproduction of daughter genes just like themselves. The new genes were exact duplicates of the old ones, showing no demonstrable mutations, or at most such a scattering few as might have occurred anyhow.

And yet mutations certainly do happen, even though rarely. In the examination of over twenty million fruit-flies, not specifically maltreated, over four hundred visible mutations have been found. These mutations must have causes. What then can the causes be? What subtle conditions are they, apparently so independent even of violent injury and of other drastic and obvious changes in the physiological or pathological state of the organism? In going over the data on mutational occurrences in *Drosophila* the present writer in 1920 reported the finding of evidence that in this fly, when a mutation occurred in a given gene of a cell, not only did the hundreds or thousands of genes of other kinds in that cell remain unchanged, but even the twin gene of the other set in the same cell—*i.e.*, the originally identical gene that the individual had received from its other parent—remained unchanged also. Here, then, are two genes of identical chemical composition, lying very close to one another in the same cell—on the average less than a thousandth of a millimeter apart—and one of them is caused to mutate but its duplicate is not. Neither do the identical genes in neighboring cells mutate. Evidence for this same kind of occurrence has been adduced in other organisms. Why do not the same general conditions, acting on the same materials, produce everywhere the same results? If events in this sphere are apparently so indeterministic, is it any wonder that we could not in our previous trials, by the application of definite conditions, produce definite mutational results?

Must Explore Newly Found World of the Little For Mutation Cause

In view of these accumulating findings, the conclusion seemed to me to become increasingly probable, not that mutations were causeless, or expressions of "the natural cussedness of things," or of the devil, but that, as Troland had suggested prior to the finding of this evidence, they were not ordinarily due directly to gross or molar causes, but must be regarded as the results of individual ultramicroscopic accidents—events too far removed from us in fineness to be readily susceptible to any exact control on our part. In other words, an appeal was made to the newly found world of the little which the old-line biologist and philosopher do not take sufficiently into consideration.

The genes are not only protected by a cell membrane but by a nuclear membrane inside of that, and possibly again by a chromosomal envelope of some kind; they may be well shielded, therefore, from the reach of any poisonous substances or unusual products of metabolism. They can not, however, escape the interplay of the helter-skelter molecular, atomic and electronic motions that are con-

The Amateur Scientist

A MONTHLY FEATURE *conducted by* ALLAN STRONG BROMS

The Plant Food Factory

The leaf is the plant's laboratory in which foods are synthetically produced. The chemist on the job is the green coloring matter called chlorophyll. Its work is to sort out sunlight rejecting the green light waves, which are consequently reflected to our eyes, and absorbing the other colors composing white light, especially the red waves. These happen to be just the right length and frequency for effecting certain chemical upbuildings out of such raw materials as water (H_2O), carbondioxide (CO_2), soil salts and some nitrogen compounds. The resulting complex chemical compound contain stores of energy derived from the sunlight. They serve as foods for both plants and animals, releasing their energy by a breaking down of the complex compounds into those that are simpler. This latter process is really a slow burning, a combining of oxygen with other elements, particularly carbon, releasing energy made manifest in living activities or as heat.

To detect the process of photosynthesis, as the food upbuilding is called, perform this simple experiment. Submerge an actively growing water plant in a glass vessel and expose it to the light. Bubbles will appear on the leaf surfaces and rise through the water. When the light is strong, the bubbles will be numerous, as it diminishes, they diminish. The bubbles consist of oxygen and may be collected by turning a glass of water over above the plant without spilling. As the bubbles rise, they will now slowly fill the inverted glass. The oxygen as it comes from the plant represents an excess in the water and carbondioxide which does not enter into the more complex food compounds. That the gas is oxygen can be proved by thrusting a match in it. The match will burn with an unusual brilliancy. One can even burn iron in it by dipping the end of a steel wire into sulphur, setting fire to it, and then immersing it in the oxygen gas.

The using up of food stuffs in the process of living goes on night and day in both plants and animals. It involves the absorbing of oxygen and the giving off of carbondioxide, just the reverse of photosynthesis. It is hard to detect in plants, especially during the daytime because of the more active reverse process which hides it. But at night it becomes apparent, for every part of the plant continues this breathing, inhaling oxygen, exhaling carbondioxide, while the photosynthesis, depending upon light, has entirely ceased. This is the reason why it is unhealthy to have plants in a closed bedroom. They like the other living occupants, use up the fresh air and pollute it with their outbreathings.

---

tinually taking place both within and around them, on the part of the substances of which they and their neighbor molecules are naturally composed. Nor can they escape the buffeting action of the electromagnetic stresses and strains occurring through space in the field in which they lie immersed. These various exchanges of energy are not, it is evident, ordinarily consequential enough, or the energy is not directed in sufficiently telling ways, to so distort a gene as to change its composition permanently. Occasionally, however, such a change does occur, and subsequent generations tell the tale.

Research Laboratory of the University of Texas, where Professor Muller and associates experiment with X-rays and fruit-flies to discover the roots of life. Note the hundreds of culture bottles. The results of these epoch-making experiments, showing how mutations were increased 1500 *percent, will be described in the next issue of EVOLUTION. Bring this to the attention of your friends.*

Question Box

Answers by Allan Strong Broms, unless otherwise credited

WHY DOES EVOLUTION BRANCH OUT?

Q.—In his debate, Prof. McCabe said that in Australia and New Zealand only those groups of animals are found that were also on the mainland before those islands were detached and he uses that as a proof of evolution. Now, if higher species developed on the mainland of Asia why did they not also develop on these detached islands? G. J. S.

A.—So far as we know, evolution is not guided along any set lines by outside direction that could keep it alike in two or more detached areas. Evolution occurs in plants and animals through variations (in all sorts of directions) which help or hinder the organisms in their struggles to survive. If, under existing conditions, such variations aid survival, they tend to be preserved by heredity, otherwise they are weeded out by this so-called "natural selection." If exactly the same variations were to be repeated under exactly the same conditions on both mainland and island, then only would the evolutions tend to be parallel. But any given favorable variation or series of variations (such as those producing the warm-blooded, fur-bearing mammals) is not likely to be repeated under exactly the same conditions of climate and other surroundings, so it is very improbable that any given course of evolution will be duplicated on mainland and island after detachment.

Furthermore, isolation on islands or by mountain barriers often protects organisms from evolution-stimulating severity in the struggle for existence. Life then becomes too easy and the organisms just stay put. Or the conditions of life, though severe, just because they are different, promote divergent evolutions, each adaptive to local needs.

Marked steps in evolution generally come through environmental changes. If environmental changes diverge, so will the resulting organic evolutions. We are pretty sure, for example, that the warm-blooded mammals arose during the Permian glacial period that man himself evolved in a relatively treeless region when aridity gradually wiped out the forests that had protected his ape ancestors, and likewise that man's inventive mind evolved under the severe necessities of the Pleistocene ice age. Such conditions were, however, just local, and evolution proceeded elsewhere but hestitatingly, or not at all, or in other directions.

ARE BIRTHMARKS CAUSED BY FRIGHT?

Q.—Are birthmarks caused by fright of the mother? P. K. M.

A.—The superstition that birthmarks are due to fright of the mother during pregnancy is one that all mothers seem to accept and all scientists deny. When a child is born marked, it is so easy for the mother to search her memory for a fright and find it. And mothers, despite the doctors, will probably forever try to make geniuses of their unborn babies by themselves studying art, music and literature. The studies fortunately do no harm and may later be passed on to the children by education. But biologists are very sure that no more direct influence can be counted on.

A child starts to grow from a germ cell derived from the father and mother, and the mixture of parental traits in this original cell determines the characteristics of the child to be born. Then the training or mutilations of the parents' bodies before conception do not seem to be transmitted to the child. Once the child starts its growth, it is completely protected from outside influences. No nerves pass from mother to child to carry mental or emotional impressions, only a tube for the blood that bears oxygen and food-liquids to the child and wastes from it. Even then, the mothers blood stream does not reach the child, but trades its burdens at the doorstep, so to speak, where they are filtered through thin membranes into the child's blood stream. These membranes, furthermore, are very choosey as to what shall pass through. Poisons of disease or fright or worry are strictly barred. Our unborn babies are better safeguarded than we know.

IS THERE A SEAT OF LIFE?

Q.—Is there an organic seat of life in the human body? If so, where is it located and how does it function? C. D. V.

A.—If you mean, as I assume, a particular organ or spot as the cause, container and controller of life, the answer is surely "no." That disposes of the second part of your question, but the answer itself needs amplifying. I really mean that modern biologists do not set apart any one organ as the seat of life. An organism consists of a vast number of cells making up tissues grouped into organs, most of them living and interdependent in their living. Life permeates every part and does not emanate from any single part. Of course, there are tender and indispensible spots, to destroy or injure which destroys life. But there are several such, so no single one can properly be called the seat of life. Each has evolved with the body as a whole to do its essential part in the elaborate process of living, but it can do only that part and depends upon other organs to do other necessary things.

Scientific biologists do not think of life apart from the organism and make no use of the conception of a separate spirit or soul which can settle down in some "vital center" and so give life to an otherwise dead body. The scientific mind is not tricked by such ideas that pretend to explain, but digs for the deeper explanations in the laws of physics and chemistry as they operate within the organism.

WHO IS HE?

Fundamentalists often try to bolster up their cause by quoting "authorities" of whom we've never heard. Readers will perform a useful service by helping to trace them down. Our wideawake friend, O. O. Whitenack, wrote the following self-explanatory letter to Sir Arthur Keith of London:

Dear Dr .Keith:

An article against the theory of evolution is being circulated in Denver in which the following quotation is emphasized: "Nine-tenths of the talk of evolutionists is sheer nonsense, not founded on observation, and wholly unsupported by facts. This Museum is full of proofs of the utter falsity of their views.—Dr. Etheridge, of the British Museum." Any information you may be able to give me concerning the genuineness of this quotation will be greatly appreciated.

(Signed) O. O. Whitenack.

To this Dr. Keith replied:

London, W.C.2. March 4, 1929.

Dear Mr. Whitenack:

The "Dr. Etheridge of the British Museum" who is credited with the statement that "nine-tenths of the talk of evolutionists is sheer nonsense" is not known over here either at the British Museum or elsewhere. So we must conclude he is a "Mrs. Harris" which fundamentalists have created to tell lies for them.

(Signed) ARTHUR KEITH

If any of our readers know the pedigree of this "Dr Etheridge" or any other "Mrs. Harris," we'll be glad to print it.

Funnymentals

"We affirm again that for sheer cowardice and incapacity the advocates of evolution have never been eqnalled; and it becomes increasingly evident that their philosophy is as bestial in its fruits as in its roots." Christian Fundamentalist, May 1930.

"Evolution is the greatest farce ever foisted upon an unsuspecting public. The most frightfnl insult ever handed to an all-wise Creator since the creation of man. It is the strangest phenomena humanity has to contend with today. A tremendous chain of circnmstancial evidence supported by vague analogies and figures of speech. It remains today an erroneons doctrine, unproved and without a shadow of scientific evidence. Notwithstanding this, more than 75 percent of our educators in leading Universities teach this beastly doctrine." (Rev. Fred Johnston, June 1929 Defender.

"If I believed that life ends with death and that there is no punishment after death I would be less apt to tell the truth." Judge Barnhill, in the "Gastonia Case."

"The king of England will have to order Darwin's remains removed from the abbey, for with the blasting of his theory of the ape origin of man, Darwin is no longer a great man. His fame has been transmuted into infamy by Osborn's Des Moines speech. His "Origin of Species" will have to be recalled and burned, lest fnture generations revere the ape, now declasse. Replicas of his bust, enshrined in so many museums and halls of fame, will have be taken out to the rubbish heap. Multiplied millions of textbooks, nsed by our youth the world over in High Schools and Colleges, will have to be junked, for Darwin and his tremendous contribution to science—the ape theory—are now consigned to limbo by Osborn." Signs of The Times, Jan. 14, '30.

IS THE FUNDAMENT CRUMBLING?

At the International Convention of the World's Christian Fundamentals Association in Los Angeles this Jnne Fundamentalist Wm. B. Riley affirms "That the creative days of Genesis were Aeons, Not Solar Days" in debate against a still more Fundamental Fundamentalist, Harry Rimmer. We're afraid that it's too early to welcome Riley to the ranks of evolution, but invite you to note how our cartoonist, George Wotherspoon, sizes up the situation.

MY CONCERN

Some show alarm for family tree,
And little for posterity;
What worries me far more than past,
Is how to break my life long fast.

I'm more concerned with truth and life,
Than ignorance and jealous strife;
I'd rather from a monkey be,
Than have a monkey made of me.

J. CLYDE KEEGAN

Statement of the Ownership, Mangagement, etc., Required by the Act of Congress of August 24, 1912,

Of EVOLUTION published monthly at New York, N. Y. for April 1, 1930.
State of New York)
County of New York)ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared L. E. Katterfeld, who, having been duly sworn according to law, reposes and says that he is the Managing Editor of the Evolution and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management etc. of the aforesaid publication for the date shown in the above caption,

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:
Publisher Evolution Publishing Corporation 112 East 19th Street, New York, N. Y.
Editor none
Managing Editor: L. E. Katterfeld 112 East 19th Street, New York, N.Y.
Business Managers none

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock.)
Evolution Publishing Corp. New York,
Allan Strong Broms, New York, N. Y.
Martin Dewey, New York, N. Y.
Wm. King Gregory, New York, N. Y.
M. Mark, Swayzee, Ind
L. E. Katterfeld, New York, N. Y.
A. Nielen Cincinnatti, Ohio.
Frank A. Sieverman, New York, N. Y.
Elihu Thomson, Swampscott, Mass.
Morris Weinberg, New York, N. Y.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are:
None

L. E. Katterfeld Man. Ed.

Sworn to and subscribed before me this 7th day of May, 1930
Fay Siegartel
(My commission expires March 30, '31)
Kings Co. Clk. No. 1420 Reg 1875
N. Y. Co. Clk. No. 2191 Reg 1S48A

NOTE OUR NEW ADDRESS:
112 East 19th Street, New York, N.Y.
NEW SUBSCRIPTION RATES:
Single subscription, $2. per year. For $5 we'll send you a Five years subscription, or a bundle of 5 copies one year to one address, or five yearly subscriptions to different addresses.

TO TEACHERS OF BIOLOGY:
A number of High School biology departments are using EVOLUTION with splendid results. Some of them take 100 copies of each issue for their students. Find out for yourself how EVOLUTION will arouse the interest of your students by ordering a bundle of this issne at once. The rate is 10 for $1,; $10.00 per 100, and we send you two extra copies with every ten you order.

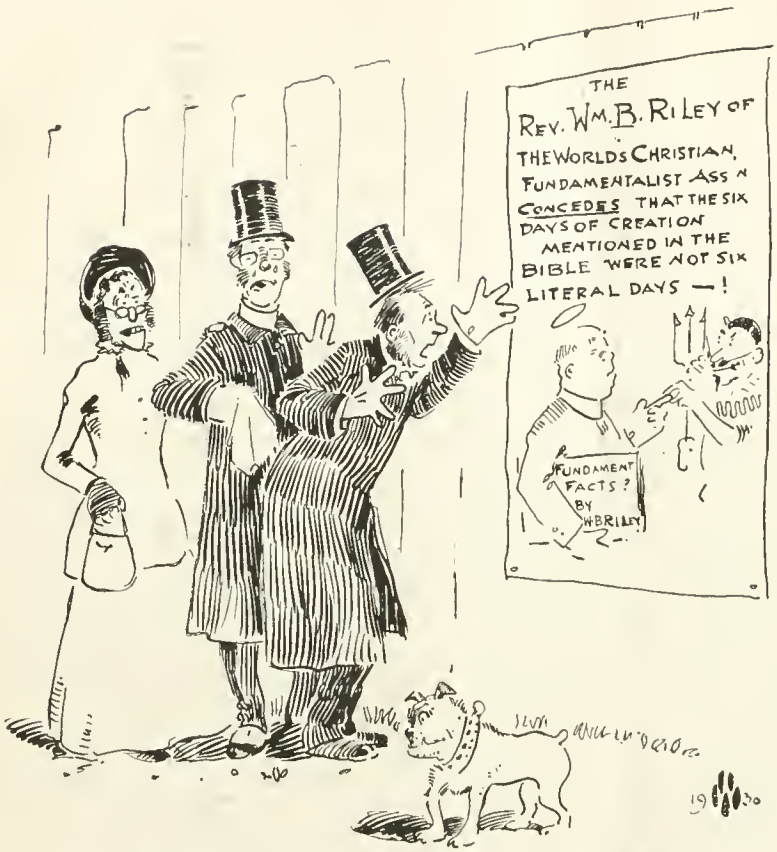
IF YOU HAVE MOVED:
Be sure to send us your old address as well as yonr new one so that we can correct our geographic mailing list Please bring this to the attention of any one whom you may hear complain abont not receiving this issue of EVOLUTION. Many of our old subscribers will have moved since our last issue and we shall appreciate this cooperation of our friends to locate them.

FOR GRADUATION PRESENTS:
What more appropriate and acceptable gift than a good book? Especially some book of natural science, which wil open a new window in the mind of the reader, and forever after enable him to look out and see and nnderstand more of the world? We'll gladly send any book of any publisher at regular publisher's price. And if you'll include only one dollar extra we'll send EVOLUTION one year to whomever you select.

TO KEEP abreast of SCIENCE:
Two journals, "Scientific Monthly" and "Science," both edited by J. McKeen Cattell, are essential. They're always interesting; every number worth reading. We'll forward your subscription:—
SCIENTIFIC MONTHLY, year, $5.00
SCIENCE (weekly) per year, $6.00
With EVOLUTION one year, simply add a dollar. **All three, $11.00**
EVOLUTION, 112 E. 19 St. New York

THE GREAT EVOLUTION DEBATE
Between Prof. Jos. McCabe and Rev. W. B. Riley, which Riley would not publish in his fundamentalist magazine, appeared in full in three issues of EVOLUTION. Postpaid, 25c; to ten or more addresses 20c each. Fire a broadside.

SCIENCE LEAGUE OF AMERICA
Champions Freedom of Science Teaching. Write for pamphlet to 504 Gillette Bldg, San Francisco.



THE GREAT BETRAYAL

QUESTIONS FOR A QUIZZ BASED ON THIS ISSUE

Is Evolution a Fact? See page 3
Is Evolution "directed?" 5, 15, 18
What Is Real Education? 2
Where Did Life Originate? 7
How Did Hardships Help Evolve Human Mind? 8
When Did the Last Ice Age End? 11
How Estimate the Age of Niagara? 11
How Can You "Feel" Earth Movements of Millions of Years Ago? 12
How Are "Synthetic" Foods Produced? 17
How And What Do We Inherit? 4, 5, 18

IN OUR NEXT ISSUE:

What Causes Evolution?
How did Sex evolve ?
Does Matter evolve?

TO DISPEL THE DARKNESS BY SPREADING LIGHT

is the mission of EVOLUTION. The advance guard of humanity, the men of science, are forging forward into the light at an ever increasing pace. But unnumbered millions, even in this land of ours, lag behind in the mental gloom of the Dark Ages.

THIS GREAT RESERVOIR OF IGNORANCE

is an ever present danger, especially in a country where laws can be made by popular vote. It may be lashed into fury any moment to suit the purposes of demagogic dogmatism.

TWO INTERNATIONAL FUNDAMENTALIST CONGRESSES

take place this month in Chicago and in Los Angles. This marshalling of their forces undoubtedly presages another onslaught of bigotry and superstition upon Freedom of Teaching. It probably means another referendum this year to outlaw the teaching of Man's descent, the fact that he is kin to all the rest of life.

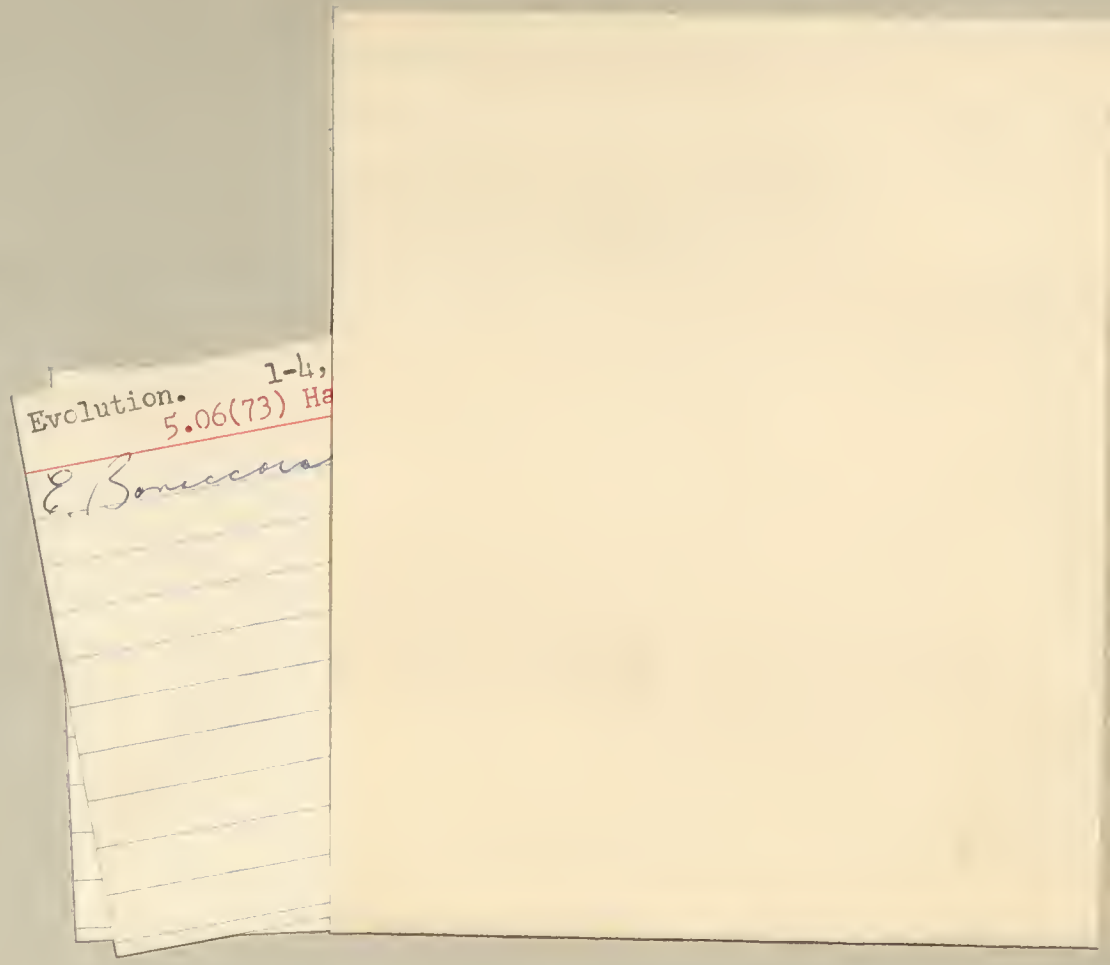
POPULAR EDUCATION IN NATURAL SCIENCE

is the only way to meet this situation. Ignoring it will not solve it. Arguing about constitutionality will not help. LIGHT is the only antidote for Darkness. EVOLUTION is published for the purpose of MORE LIGHT. *YOU* are called upon to help spread it.

BECOME AN "EVOLUTION FOUNDER"

by sending a contribution at once to help with this great and worthy effort at popular education. The budget for this year calls for $20,000. Every thousand dollars will enable us to mail out twenty thousand samples to prospective subscribers. Every contributor of $5 or more toward this fund will be enrolled as one of the FOUNDERS OF EVOLUTION. Let us hear from you in proportion to your means.

Address: EVOLUTION, 112 East 19th Street, New York, N. Y. Phone: ALGonquin 5919



Gaylord
MULTIBINDER
Syracuse, N. Y.
Stockton, Calif.